

A Study on the Evolutionary Trends of the New International Seed Industry Competition Landscape Shaped by M&A of Multinational Seed Companies - Postprint

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Date: 2019-03-05T00:00:00+00:00

Abstract

The third wave of large-scale mergers and reorganizations among multinational seed enterprises has forged a new round of international seed industry competition, with intellectual property protection constituting one of the primary driving forces behind such consolidations. Investigating the accumulation and reorganization of core intellectual property resulting from multinational seed company mergers and acquisitions enables a more profound examination of the transformation trends in the emerging international seed industry competition landscape. Trend one: the United States, Japan, and Europe remain the dominant leaders and monopolists in global breeding R&D and innovation activities. Large-scale mergers and reorganizations have facilitated the integration of technology and resources, elevating international seed industry concentration. Globally, 42.75% of patent applications in the seed industry are concentrated in the United States, Japan, and the European Union, which also hold 64.68% of DNA recombination technology patents worldwide. Trend two: intellectual property has become a powerful instrument for multinational seed companies to sustain market competitive advantages. These companies are the proprietors of core seed technology patents; the breeding patent applications of Bayer/Monsanto, ChemChina/Syngenta, and DuPont Pioneer/Dow represent nearly 14% of total global breeding patent applications, and multinational seed companies control over 81% of transformation events in global crops. Conducting research and analysis on the evolving trends of this new international seed industry landscape can furnish valuable policy recommendations for mergers and reorganizations within China's seed industry.

Full Text

Preamble

Research on the Changing Trend of the New Pattern of International Seed Industry Competition Formed by Multinational Seed Company Mergers and Acquisitions

A Case Study of Intellectual Property

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Abstract

The third wave of large-scale mergers and reorganizations among multinational seed companies has created a new round of international seed industry competition, with intellectual property protection serving as one of the primary driving forces. Examining the accumulation and reorganization of core intellectual property rights formed through these mergers enables a deeper investigation into the evolving trends of this new competitive landscape.

First, the United States, Japan, and Europe remain the dominant forces and monopolists in global breeding R&D innovation. Large-scale mergers and acquisitions have enabled technology and resource integration, significantly increasing international seed industry concentration. Specifically, 42.75% of global seed industry patent applications are concentrated in the United States, Japan, and the European Union, which collectively hold 64.68% of global DNA recombination technology patents.

Second, intellectual property has become a powerful weapon for multinational seed companies to maintain market competitive advantages. These companies are the primary owners of core breeding technology patents. The combined breeding patent applications of Bayer/Monsanto, ChemChina/Syngenta, and DuPont Pioneer/Dow account for nearly 14% of total global breeding patent applications, with multinational companies controlling over 81% of global crop transformants.

Analyzing these trends in the evolving international seed industry landscape can provide valuable policy recommendations for China's seed industry consolidation.

Keywords: Multinational Seed Companies; Breeding Technology Patents; Plant Variety Rights; Seed Market Share

1. Data Sources and Methods

1.1 Patent Data

Patent data for this study were obtained from the China National Intellectual Property Administration Patent Database (<http://www.pss-system.gov.cn/>), which includes patent data from 103 countries, regions, and organizations, along with citation, patent family, and legal status information. This comprehensive database was selected as the data source for this analysis.

Patent searches were conducted using International Patent Classification (IPC) codes. For breeding patents, we followed the “Technology Fields and IPC Classification Correspondence Table” published by the OECD, using classification codes A01H and C12N15. Patent data were then categorized and organized by time, country, company, and classification code. The search included patents published up to December 31, 2017.

1.2 Market Data

Market data were collected from two primary sources: 1. International Seed Federation (ISF): <http://www.worldseed.org/resources/seed-statistics/> 2. Financial statements (2007-2017) of three major multinational seed companies: Monsanto, Syngenta, and Bayer

2. Global R&D Landscape in the Seed Industry

2.1 US, Japan, and Europe Dominate Global Seed Patent R&D, with China Emerging as a Major Player

From 1985 to 2017, global seed industry patent applications grew at an annual rate of 8.62%, exceeding 1.31 million applications [Figure 1: see original paper]. These patents were filed in over 20 countries and regions, with 42.75% of applications concentrated in the United States, Japan, and the European Union [Figure 2: see original paper]. The primary focus area was DNA recombination technology (C12N15/09), which accounted for 57.02% of total patent applications in this field globally. This demonstrates that despite changes in the global seed industry landscape, these three regions continue to lead and dominate seed R&D.

In recent years, China has also emerged as a major player in seed technology R&D. Since the establishment of China’s patent system in 1985 and the publication of the first batch of seed technology patents in 1993, China has achieved annual breakthroughs in seed technology R&D. Following the State Council’s 2011 “Opinions on Accelerating the Development of Modern Crop Seed Industry,” China’s seed technology patent applications have surged dramatically. The proportion of China’s annual patent applications in the global total increased from 0.91% in 1993 to 41.38% in 2017 [Figure 3: see original paper]. In the seed technology field, patent applications have focused primarily on DNA or RNA

fragments (C12N15/11) and introducing foreign genetic material using vectors (C12N15/63). Applications in these two research areas have reached 26.62% of the global total in the same fields, surpassing both the EU and the United States.

2.2 Plant Variety Rights Have Become Strategic Resources for National Market Monopolization

Plant varieties are core elements of agricultural production, and variety rights represent strategic resources for future agricultural development worldwide. Global applications for plant variety rights have grown almost linearly [Figure 4: see original paper], exceeding 320,000 applications by the end of 2016, with over 110,000 currently valid rights. As shown in [Figure 5: see original paper], the United States leads in variety rights applications, accounting for 11.59% of the global total, followed by Japan and the Netherlands. China ranks fifth, with 6.23% of total global applications. The top three countries and international organizations (EU, US, Netherlands) account for over 40% of global variety rights applications, demonstrating that nations are intensifying protection of plant variety rights to monopolize the global seed market.

In terms of crop types, other countries' variety rights applications concentrate primarily on vegetables and flowers. For example, in Japan, flower variety rights alone account for 74.26% of the country's total variety rights applications. In contrast, China's applications for vegetables and flowers constitute less than 15%, with over 80% concentrated on field crops. This indicates that developed countries maintain absolute innovation advantages and international competitiveness in vegetables, flowers, and other specialized crops.

2.3 DNA Recombination Technology Remains a Hotspot in Global Seed R&D

As shown in Table 1, DNA recombination technology accounts for the largest number of patent applications. From 1985 to 2017, applications in this field exceeded 580,000, representing 64.68% of total global seed technology patent applications. The second largest category is flowering plants (70,334 applications), followed by vectors or expression systems specifically suitable for eukaryotic cell hosts—for plant cells. DNA recombination technology represents the most fundamental, core, and competitive technology branch in the seed industry, with innovation entities primarily relying on patents for intellectual property protection, resulting in significantly higher application volumes than other technology branches.

Figure 6 [Figure 6: see original paper] illustrates that DNA recombination technology has remained a hotspot in global seed R&D throughout the 33-year period from 1985 to 2017, reaching its peak in 2003 with 39,000 applications. After 2006, applications in DNA recombination technology began to decline, but research in three related technology areas—flowering plants, DNA or RNA

fragments, and vectors specifically suitable for plant eukaryotic cell hosts—has continued to deepen, with application volumes growing at rates of 14.59% (2006-2017), 53.20% (2010-2017), and 27.04% (2006-2017) respectively, showing clear upward trends.

3. Multinational Seed Companies' Dominance in Innovation and Market Control

3.1 Multinational Seed Companies as Primary Owners of Global Breeding Innovation Outcomes

Breeding technology patents best reflect the outcomes of breeding innovation. Table 2 summarizes breeding technology patents of eight major multinational seed companies, with Bayer and Monsanto holding absolute advantages in application volume. Following their successful merger, Bayer/Monsanto's patent applications will account for 10.43% of total global breeding patent applications, placing them in a leading position worldwide. The three merged entities—Bayer/Monsanto, ChemChina/Syngenta, and DuPont Pioneer/Dow—collectively account for nearly 14% of total global breeding patent applications, demonstrating that multinational seed companies are the primary owners of global breeding innovation outcomes.

Although average R&D investment per patent for major multinational seed companies continues to increase annually [Figure 7: see original paper]—for instance, Syngenta's R&D cost per breeding patent rose from \$530,000 in 2007 to \$1.08 million in 2017, a 103.77% increase over ten years—these companies continue to increase their annual breeding R&D investment, undoubtedly aiming to monopolize global breeding R&D technology and capture the global seed technology market [1].

The technology areas with the fastest-growing patent applications from multinational seed companies concentrate on mutation and genetic engineering, flowering plants, and insecticides containing heterocyclic compounds. For example, Monsanto, Syngenta, and DuPont Pioneer primarily focus on plant cell host vectors and flowering plants, with patent applications in these areas accounting for 25%, 27.23%, and 40.43% of their total applications respectively. Bayer, meanwhile, concentrates on insecticides containing heterocyclic compounds, with applications in this field representing 22.94% of its total. The combined applications of these four multinational companies in these three fields account for 41.54% of global applications in these areas, indicating that the technology barriers and monopolistic patterns constructed by multinational seed companies have already taken shape.

3.2 Multinational Seed Companies Remain Monopolists of Global Major Crop Transformation Events

As core technical achievements of transgenic breeding research, the development and approval of transformation events provide important guarantees for the industrialization of transgenic crops. Currently, over 81% of global crop transformation events are controlled by multinational seed companies. Monsanto possesses the largest number of transformation events, accounting for 26% of the total, followed by Syngenta and Bayer. Maize remains the crop with the most approved transformation events by multinational seed companies; for instance, 96% of Syngenta's transformation events are maize events, indicating that transgenic maize remains the preferred crop for multinational seed company R&D and global agricultural control.

According to the International Service for the Acquisition of Agri-biotech Applications (ISAAA) 2017 Brief [2], stacked trait transgenic crops accounted for 41% of global transgenic crop planting area by 2016, second only to herbicide-tolerant transgenic crops (47%). Consequently, transformation events with stacked traits have become the focus of R&D and commercialization for multinational seed companies. As shown in Table 4, stacked trait transformation events account for 40% of multinational seed companies' total transformation events. Monsanto leads with 69 stacked trait events, followed by DuPont Pioneer and Dow. In terms of commercial traits, herbicide tolerance and insect resistance stacked traits are the most numerous, representing 77% of total stacked traits and concentrating primarily on maize and cotton. Maize events with herbicide tolerance and insect resistance stacked traits alone account for 77% of the total, demonstrating that stacked trait transgenic crops not only receive broader application and promotion by global farmers but also represent the main focus and development trend for multinational seed companies.

This analysis reveals that multinational seed companies leverage their advanced transgenic technologies—particularly gene mining and trait improvement technologies—to monopolize global crop markets, driving continuously increasing adoption rates of transgenic crops. For example, in 2016, transgenic soybean adoption reached 78%, transgenic cotton 64%, transgenic maize 26%, and transgenic canola 24% of global planting area for each respective crop. Thus, regardless of merger conditions, multinational seed companies remain the monopolists of global crop markets [3].

3.3 The 2016-2017 Merger Wave and Market Concentration

Between 2016 and 2017, the global seed industry experienced its third major wave of mergers and acquisitions: the merger of DuPont and Dow Chemical in the United States, ChemChina's \$43 billion acquisition of Swiss seed giant Syngenta, and Bayer's \$66 billion acquisition of Monsanto. Following these complex capital operations, the global agricultural inputs industry now features a tripartite structure among China, the United States, and Germany.

Table 5 shows that the three merged entities control 61% of the global commercial patented seed market. Bayer/Monsanto and DuPont/Dow account for 30.1% and 22.7% respectively, with ChemChina/Syngenta ranking third at 7.9%. This demonstrates the formation of a clear duopolistic monopoly model in the global commercial patented seed market [5].

4. Conclusion Analysis and Policy Recommendations

Intellectual property protection has become one of the primary drivers of multinational seed industry mergers and reorganizations. This paper utilizes patent and variety rights data to conduct an in-depth analysis of intellectual property accumulation and reorganization formed through multinational seed company mergers, examining the changing characteristics of the new international seed industry landscape to provide valuable policy recommendations for China's seed industry consolidation.

The analysis yields two key conclusions. First, multinational seed company mergers and reorganizations have achieved technology and resource integration, directly leading to rapid increases in industry concentration. The three major multinational seed industry giants now hold greater discourse power in the international seed market, representing a key characteristic of the new international seed industry landscape. Second, intellectual property has become a powerful weapon for multinational seed companies to maintain market competitive advantages. Through cross-border mergers, these companies achieve intellectual property integration, clear obstacles for seed industrialization, and control and monopolize national commercial seed markets. This represents the second key characteristic of the new landscape.

Facing these trends and features of the evolving international seed industry landscape, China's seed industry must strengthen resource integration and independent innovation while vigorously cultivating independent intellectual property rights to secure a position in the global market.

First, China should promote seed industry resource integration and accelerate the cultivation of domestic multinational seed companies. In response to international seed industry trends and the impact of foreign investment on China's seed market, the fundamental approach to ensuring China's seed industry security lies in the growth and strengthening of domestic seed companies [5]. China should advance the integration of national seed industry research and business resources, accelerate integration across the entire seed industry chain, fully build a Chinese seed industry "aircraft carrier," and accelerate the cultivation of multinational companies in China's seed sector to enhance core competitiveness and increase China's dominant position and control in the international seed industry landscape.

Second, China must enhance independent innovation capabilities in the seed industry and formulate intellectual property strategies. To break through the current constraints, Chinese seed enterprises must comprehensively improve their

independent innovation capabilities, develop intellectual property strategies, effectively allocate various intellectual property elements, and establish intellectual property defense strategies for core technologies. This will enable them to maintain competitive advantages nationally and globally when facing intellectual property offensives from multinational giants.

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